Module 7 - Time Varying Circuits

ME3023 - Measurements in Mechanical Systems

Mechanical Engineering

Tennessee Technological University

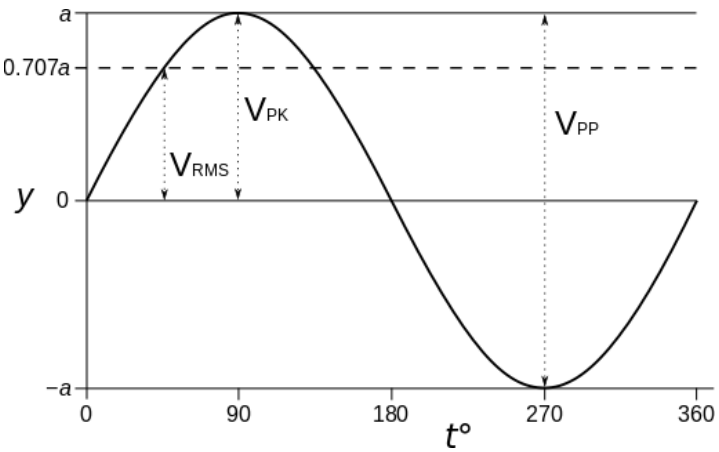
Topic 3 - Frequency Filters

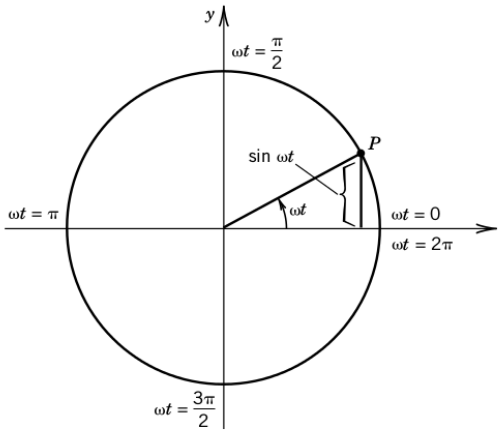
Topic 3 - Frequency Filters

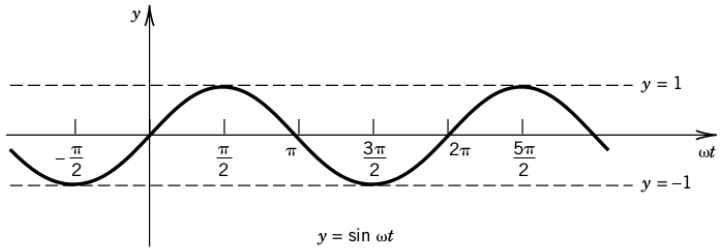
- Signal, Amplitude, and Frequency
- Filter Concept
- High-Pass, Low-Pass, and Band-Pass
- Applications

Signal, Amplitude, and Frequency

Signal, Amplitude, and Frequency



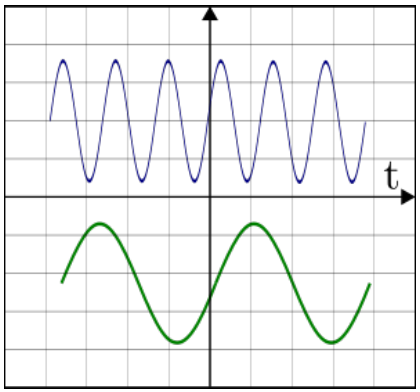


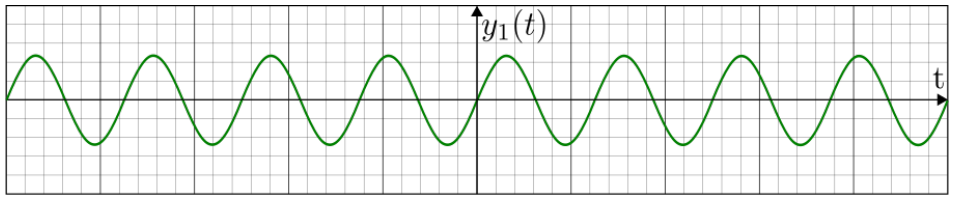


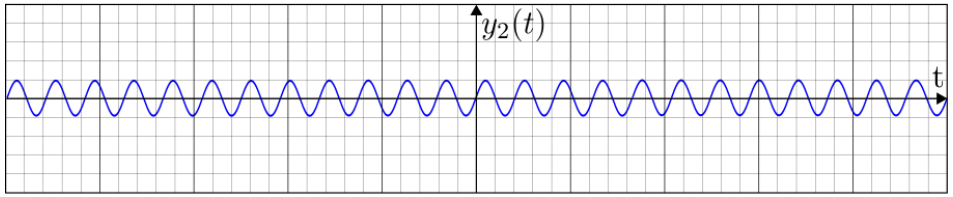
What is the relationship between the unit circle and frequency?

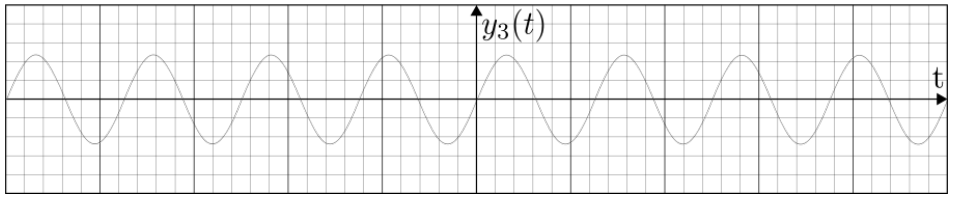
Signal, Amplitude, and Frequency

Signals can be composed of multiple *frequency components*. (see Fourier Analysis Ch2).

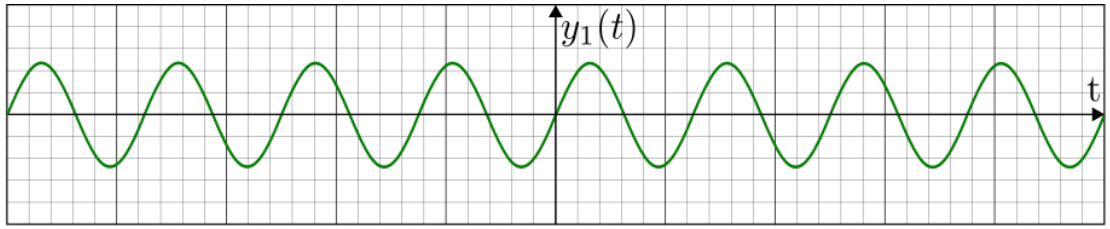


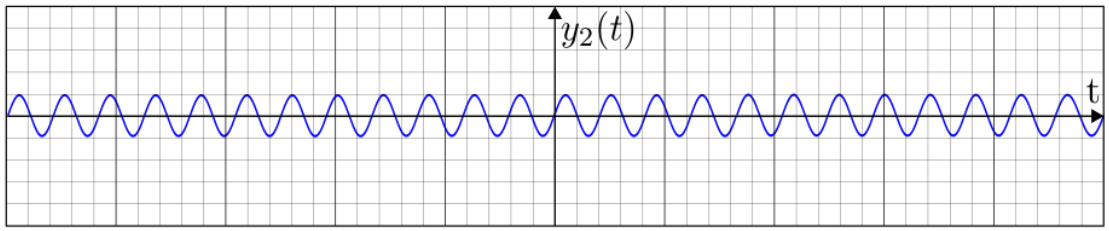


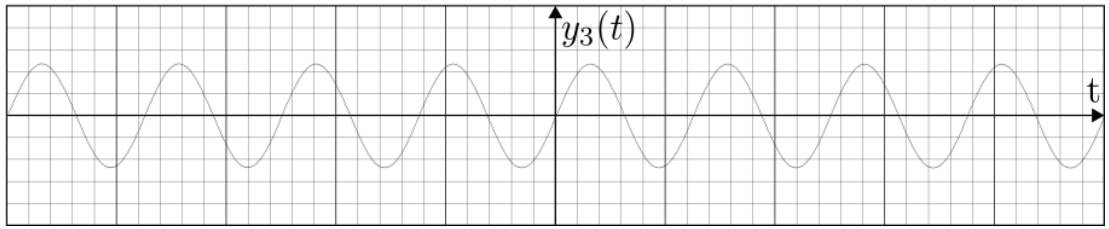




Signal, Amplitude, and Frequency

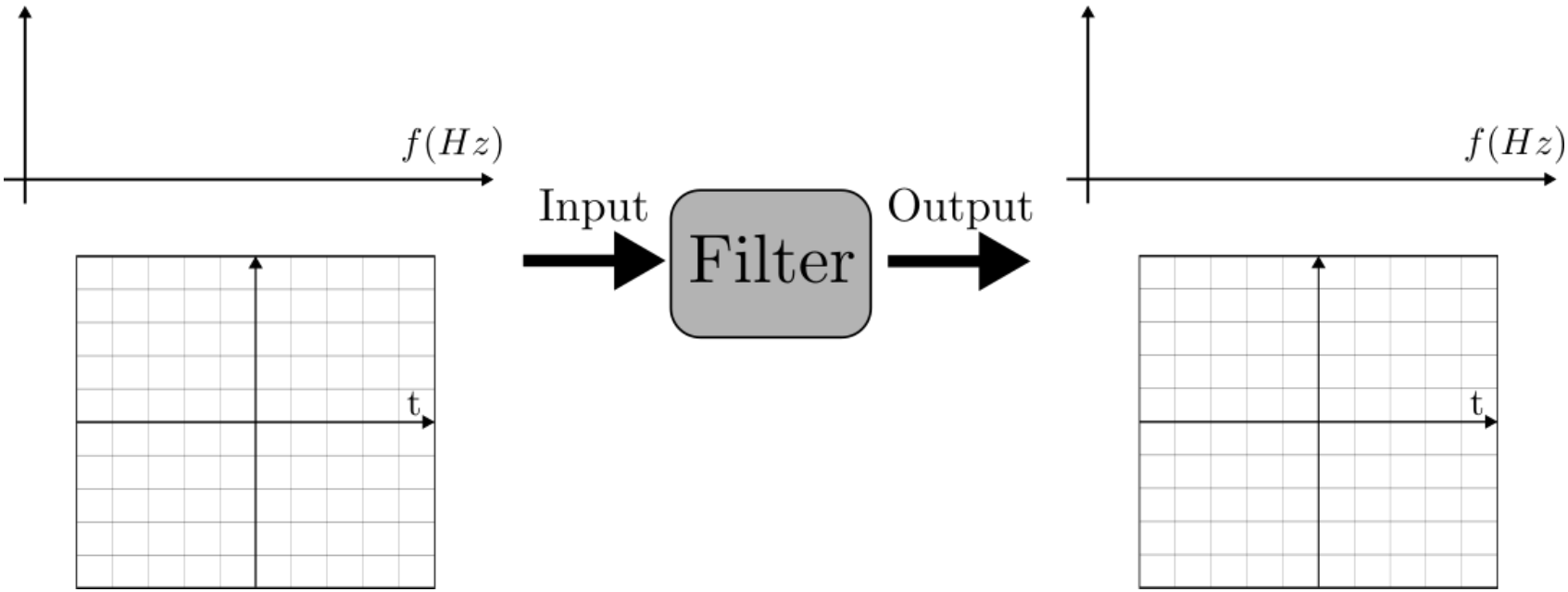






Filter Concept

A raw signal is input to a frequency filter and a filtered signal is output.



Filter Concept

So what is inside the *grey box*?

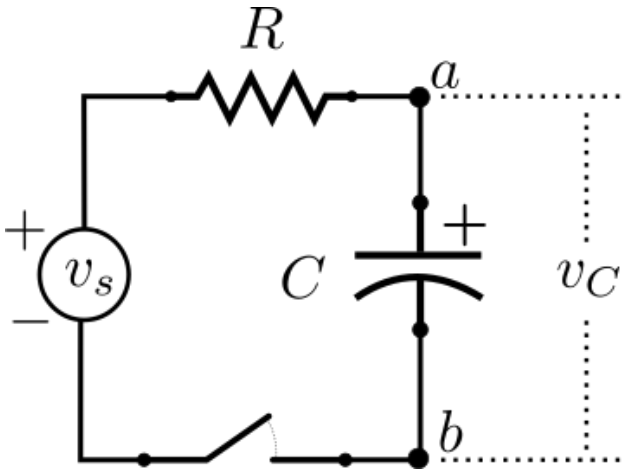
How does it work?

Filter Concept

Filters are constructed from time-varying circuits. The most basic of which is the RC filter.

First Order Model

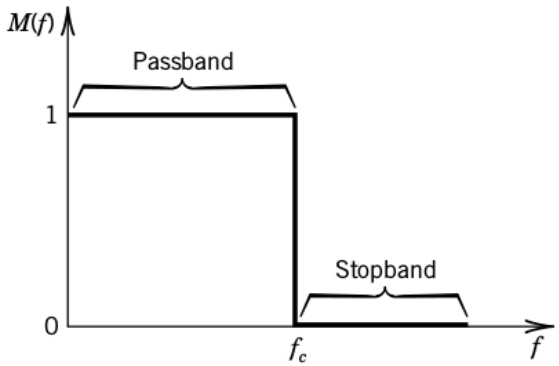
$$\tau\dot{y} + y = KA\sin(\omega t)$$



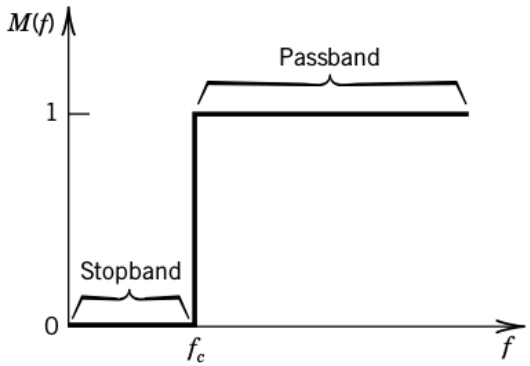
Response Equation

$$y(t) = Ce^{-\frac{t}{\tau}} + \frac{KA}{\sqrt{1+(\omega\tau)^2}}\sin(\omega t - \tan^{-1}(\omega\tau))$$

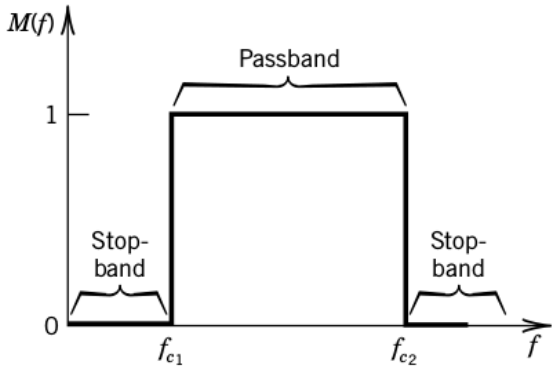
High-Pass, Low-Pass, and Band-Pass



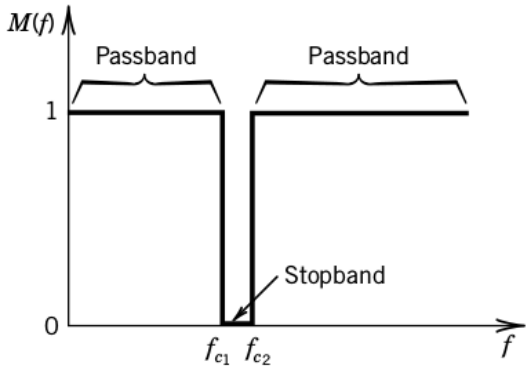
(a) Low-pass filter



(b) High-pass filter



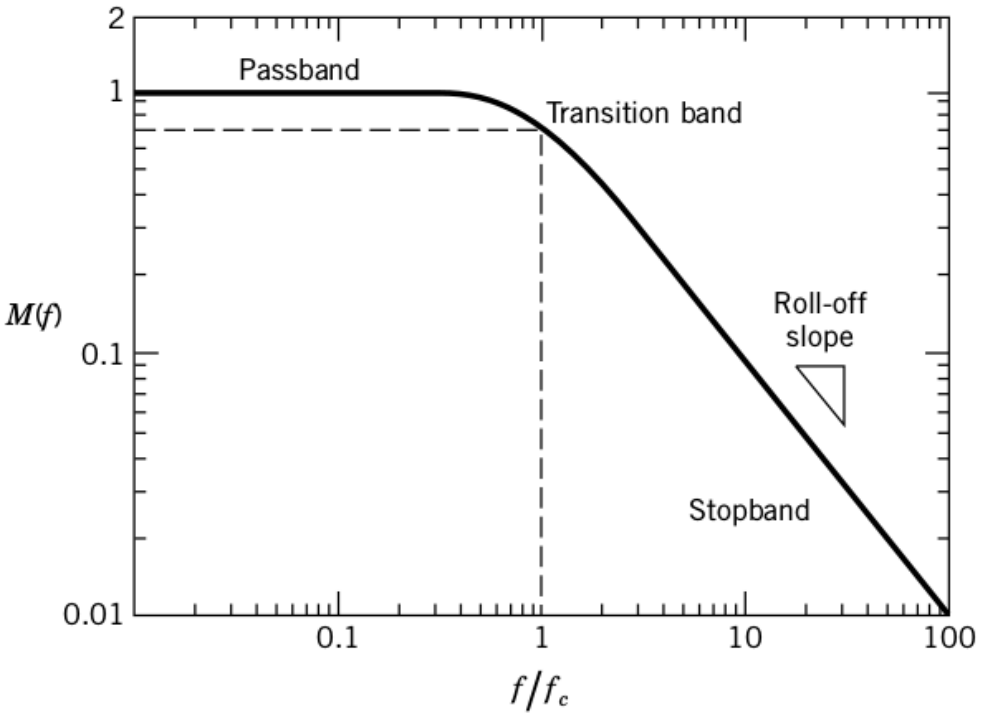
(c) Bandpass filter



(d) Notch filter

High-Pass, Low-Pass, and Band-Pass

Physical frequency filters do not behave in an ideal manner as the previous figure shows. The filter characteristics are frequency dependent.



Applications

Finally, what are filters used for?

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